UM10749

SSL5018DB1125 - 230 V/9 W A19 non-isolated buck LED driver demo board

Rev. 1 — 6 February 2014 **User manual**

Document information

Info	Content
Keywords	SSL5018DB1125, SSL5018TE, LED driver, non-isolated buck typology, A19 applications, HSO8 package
Abstract	This document describes the performance, technical data and the connection of the SSL5018 demo board, using non-isolated buck topology. The SSL5018 is an NXP Semiconductors driver IC in a HSO8 package, intended to provide a low cost, small form factor LED driver design. This SSL5018DB1125 demo board is designed for T8 applications. It is intended to operate at 230 V (AC), with an output voltage around 35 V.

Revision history

Rev	Date	Description
v.1	20140206	first issue

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1. Introduction

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Lethal voltage and fire ignition hazard

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This user manual describes the operation of the SSL5018DB1125 demo board featuring LED driver SSL5018TE in a 230 V/9 W non-isolated application.

The SSL5018DB1125 demo board is designed for driving LED loads from 30 V to 40 V with a nominal value of 35 V.

The PCB dimensions are compatible with A19 retrofit bulb applications.

The demo board provides a simple and effective solution with a high Power Factor (PF), low Total Harmonic Distortion (THD) and high efficiency for Solid State Lighting (SSL) applications.

1.1 Features

- A19 retrofit bulb application
- Open/short LED string protection
- OverCurrent Protection (OCP) and OverTemperature Protection (OTP)
- PF > 0.93 and THD < 21 % at nominal 230 V (AC) input
- Efficiency > 89 % at nominal 230 V (AC) input
- Compliant with IEC61000-3-2 harmonic standard
- Compliant with EN55015 conducted EMI
- PWM dimmable

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2. Safety warning

The board must be connected to the mains voltage. Avoid touching the board during operation. An isolated housing is obligatory when used in uncontrolled, non-laboratory environments. Galvanic isolation of the mains phase using a variable transformer is always recommended. Figure 1 shows the symbols by which these devices can be recognized.

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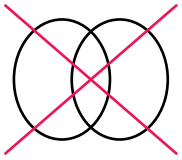
a. Isolated



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b. Not isolated

Fig 1. Variable transformer (Variac) isolation symbols

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3. Specification

Table 1. SSL5018DB1125 demo board specifications

Symbol	Description	Value
V_{mains}	AC mains supply voltage	230 V (AC) ±10 %
P_{out}	output power	8.05 W
V_{LED}	output voltage	30 V to 40 V (35 V nominal value)
I_{LED}	output current	230 mA
I_{ripple}	output current ripple	61.7 % (peak-to-peak)
$\Delta I_{LED}/\Delta V_{mains}$	line regulation	±0.4 % at V_{mains} ±10 %
$\Delta I_{LED}/\Delta V_{LED}$	load regulation	±0.8 % at V_{LED} ±10 %
η	efficiency	89 % at 230 V (AC)/50 Hz
PF	power factor	0.93 at 230 V (AC)/50 Hz
THD	total harmonic distortion	21 % at 230 V (AC)/50 Hz
T_{oper}	operating temperature	−40 °C to +105 °C
	board dimensions	24 mm × 43 mm
	conducted EMI	EN55015

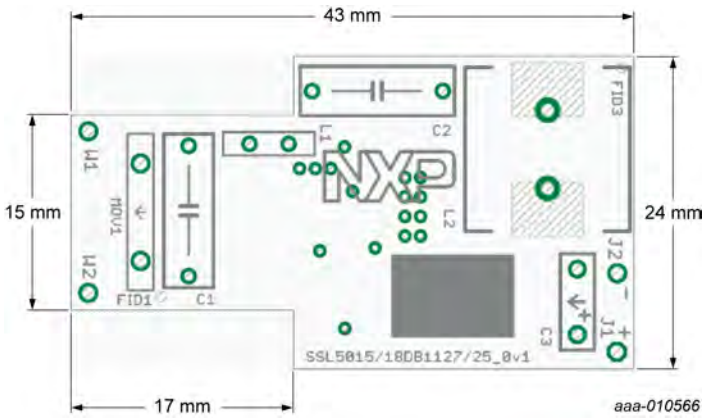

Fig 2. Dimensions of SSL5018DB1125 demo board

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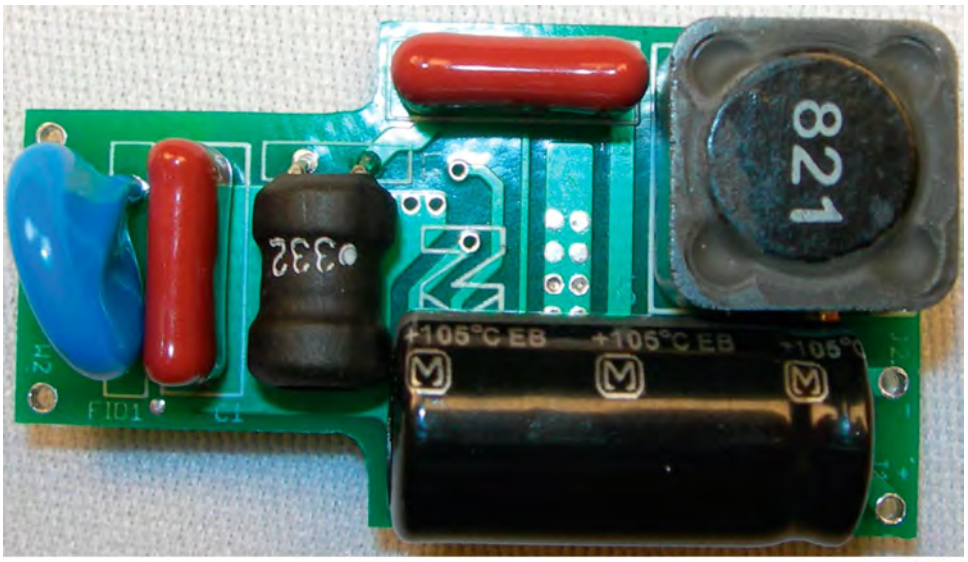
4. Board photographs



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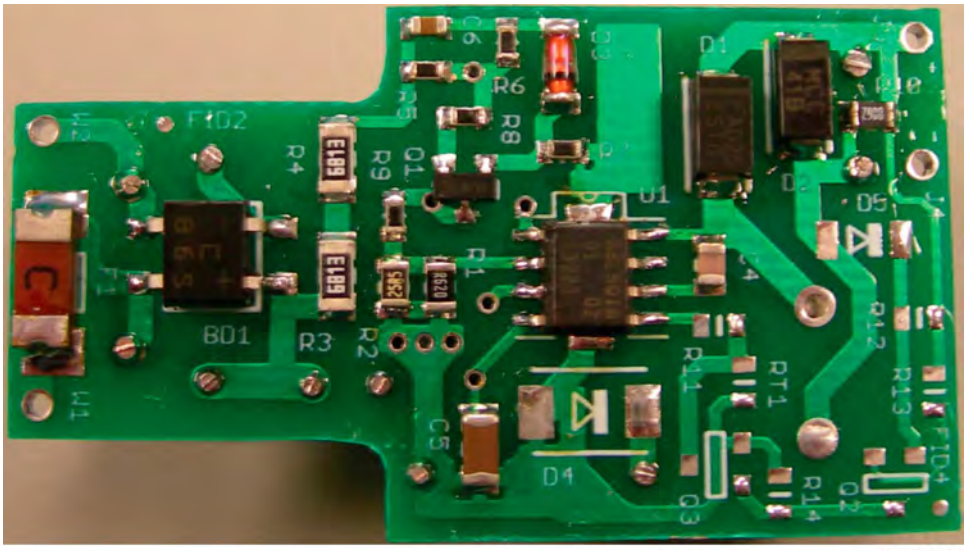
a. Top



aaa-010568

b. Bottom

Fig 3. SSL5018DB1125 demo board photographs

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5. Connecting the board

The board is optimized for a 230 V (AC)/50 Hz mains supply. It is designed to work with multiple LEDs or an LED module.

Under the expected conditions, the output current is 230 mA when using an LED string with a 35 V forward voltage (V_F). The current can be adjusted using resistors R1 and R2.

W1 and W2 are the connections for the mains voltage. J1 (LED+) and J2 (LED-) are the connections for the LED load. Figure 4 shows the connections.

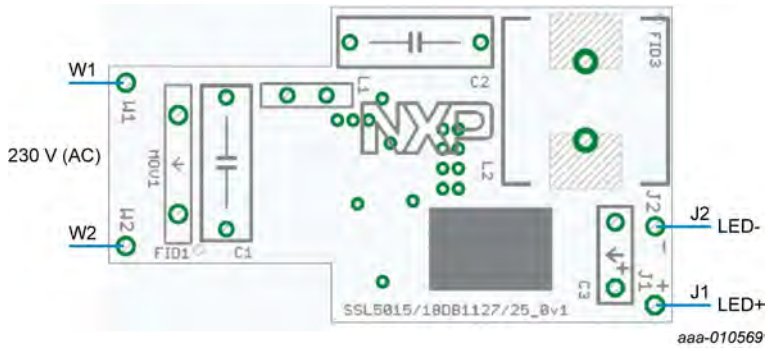

Fig 4. Connections of SSL5018DB1125 demo board

6. Functional description

6.1 Input filtering

Capacitors C1 and C2 and inductor L1 filter the switching current from the buck converter to the line. Capacitors C1 and C2 also provide a low impedance path for the switching current. The value must to be low to keep the power factor > 0.9.

Varistor MOV1 across the AC line provides protection against transient surge voltages. A footprint for an optional Transient Voltage Suppressor (TVS) is available on the board after the Differential-Mode (DM) filter. Diode D4 can be added to increase the immunity to the line surge (see Figure 7).

6.2 Power factor adjustment

A power factor improvement circuit is included for high PF and low THD design. Resistors R3, R4, R5, R6, and R7, capacitor C6, and diode D3 modulate the base voltage of transistor Q1 based on the rectified mains. So, transistor Q1 provides modulated current (limited by resistor R8) together with resistor R9 to modulate the peak current detection in the source pin. The peak switching current is modulated based on rectified mains to achieve a high PF and low THD in the design.

If the system only allows a power factor of 0.7, the power factor improvement circuit (resistors R3, R4, R5, R6, R7, R8, and R9, capacitor C6, diode D3, and transistor Q1) can be removed. In this case, pins S1 and S2 must be shorted for normal operation. Choose an inductor with a lower I_{peak} and decrease the value of output electrolytic capacitor for an even more cost-effective system.

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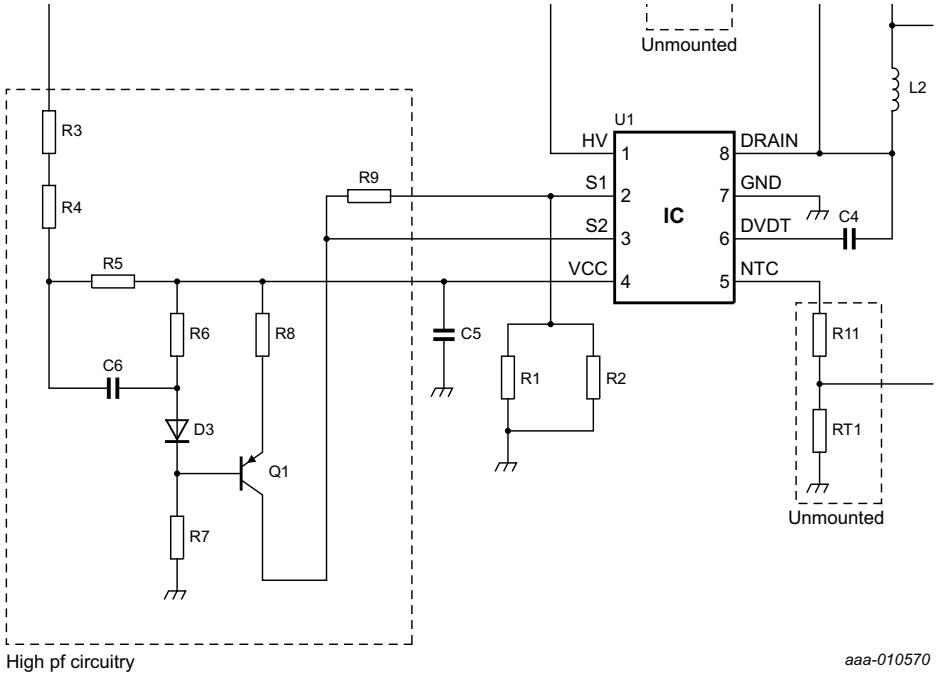

Fig 5. SSL5018TE power factor improvement circuit

6.3 Open load protection

The driver board is protected when the LED load is accidentally left open. Zener diode D2 sets the threshold voltage. Iit is shorted to trigger the short circuit protection inside the IC when the LED load is open during operation. This open load protection is non-recoverable. Zener diode D2 must be replaced after the protection event.

A footprint of optional, recoverable open load protection circuit is shown in Figure 6. Resistor R12 and diode D5 monitor the LED load voltage. Zener diode D5 sets the threshold for turning on transistors Q2 and Q3 and pulling down the NTC pin. It ensures that the IC is switched off to prevent damage.

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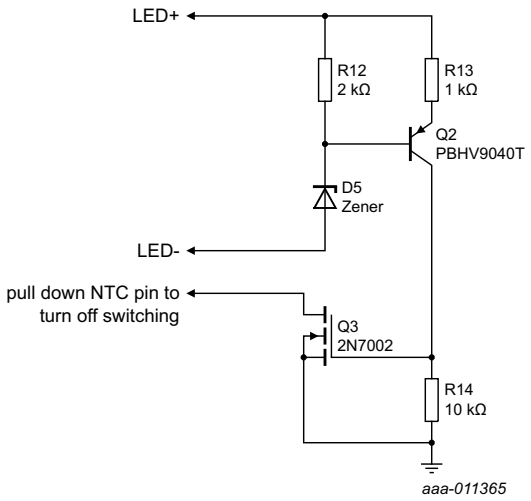

Fig 6. Recoverable open load protection (optional)

6.4 External overtemperature protection and PWM dimming

The footprints of unmounted resistors RT1 and R11 are shown in Figure 7. The purpose of these resistors is to provide thermal protection. The NTC pin can also be used as an input to disable/enable light output using a digital signal (PWM dimming). For more information about the NTC pin, see the *SSL5018 data sheet*.

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6.5 Schematic including unmounted optional circuits

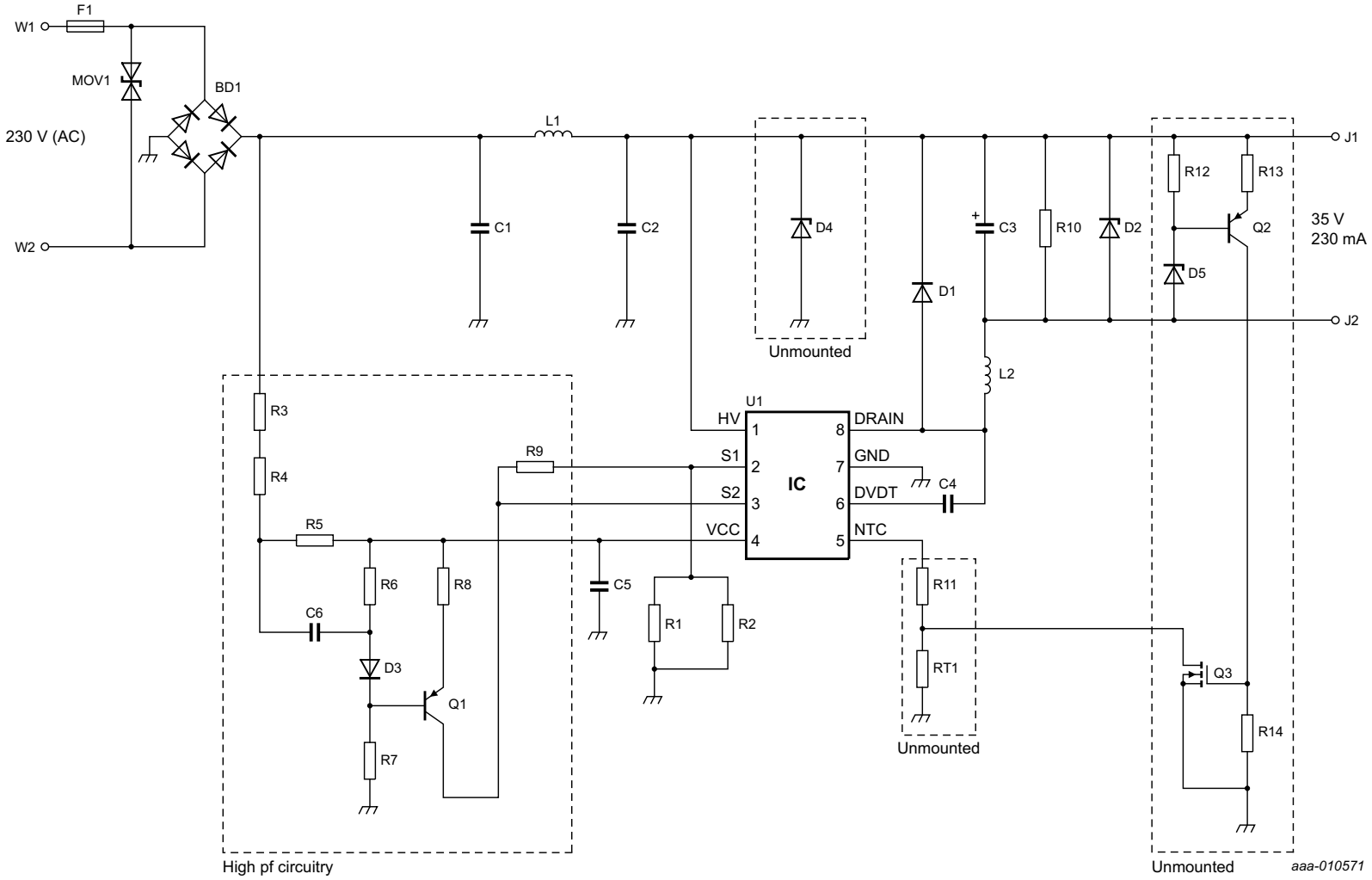

Fig 7. SSL5018TE schematic including unmounted optional circuits

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7. Performance

7.1 Efficiency

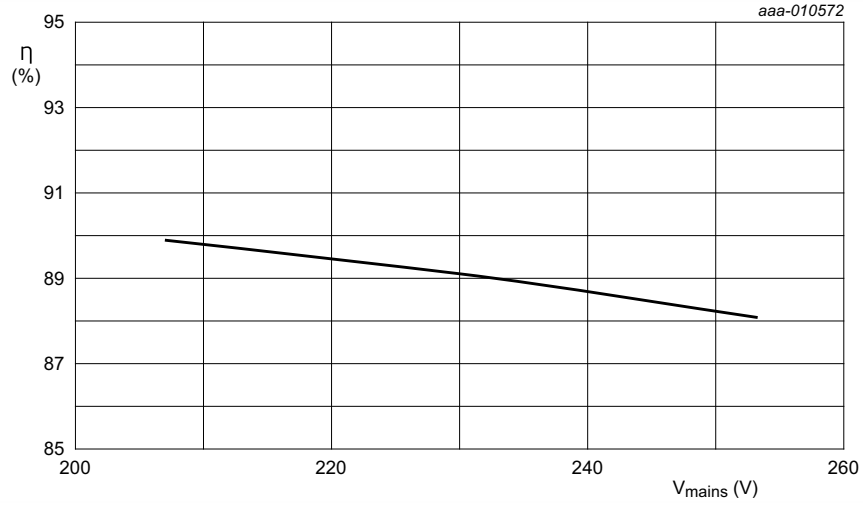

Fig 8. Efficiency as a function of mains voltage

7.2 Power factor

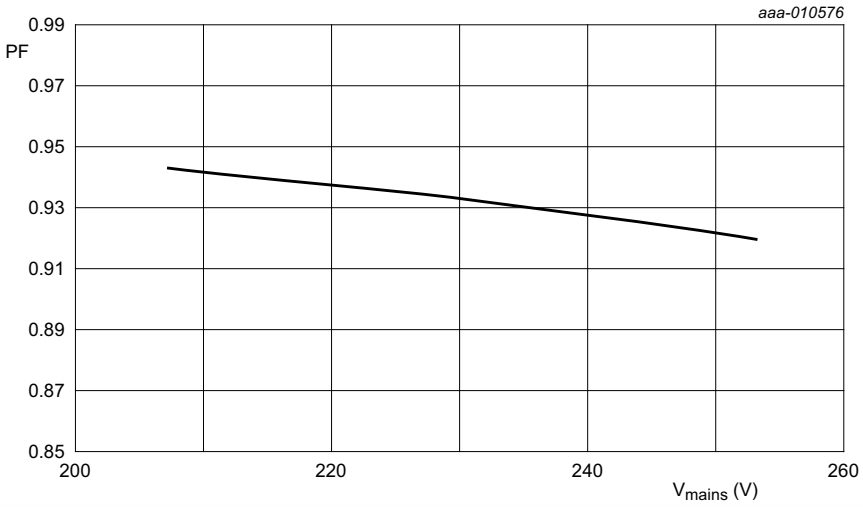

Fig 9. Power factor as a function of mains voltage

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7.3 Total harmonic distortion

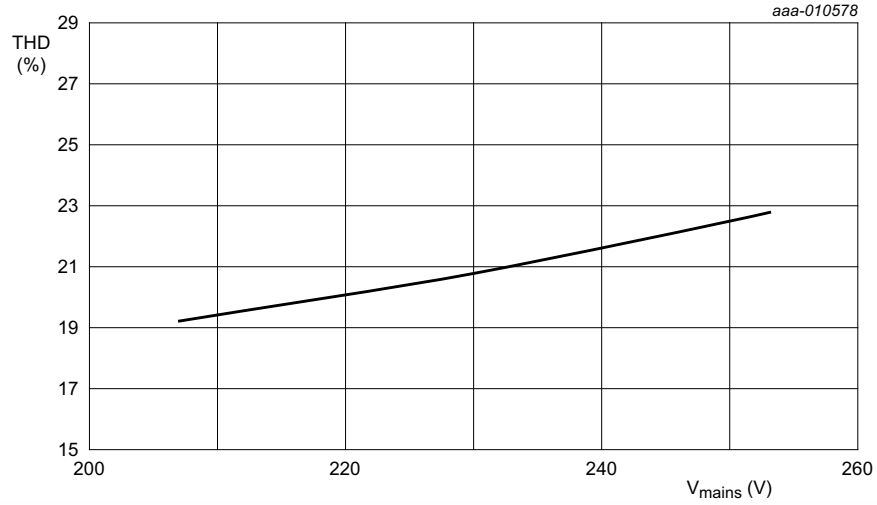

Fig 10. Total harmonic distortion as a function of mains voltage

7.4 Line regulation

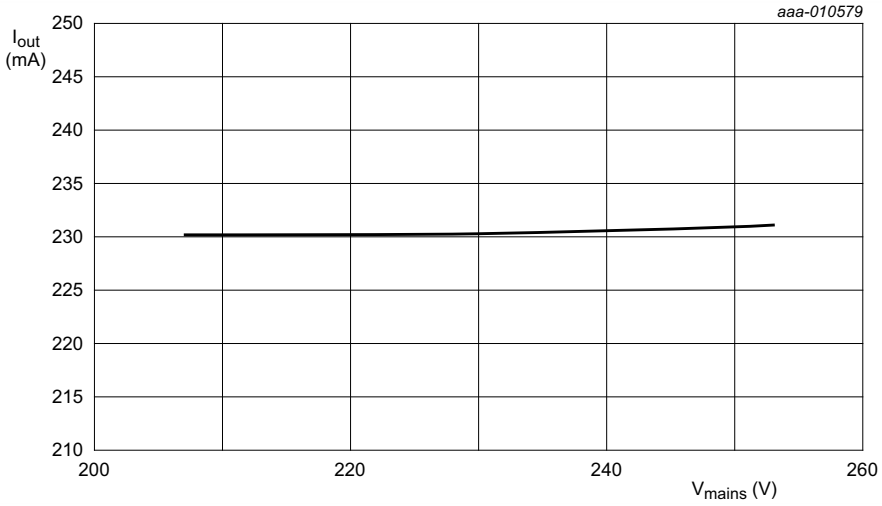

Fig 11. Output current as a function of mains voltage

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7.5 Load regulation

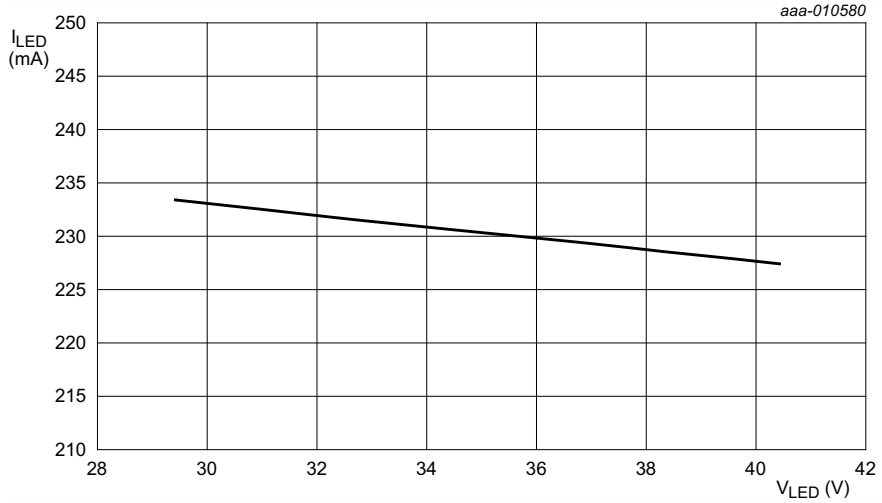

Fig 12. LED current as a function of LED voltage

7.6 EMI performance

Figure 13 shows the conducted EMI result of the SSL5018DB1125 demo board.

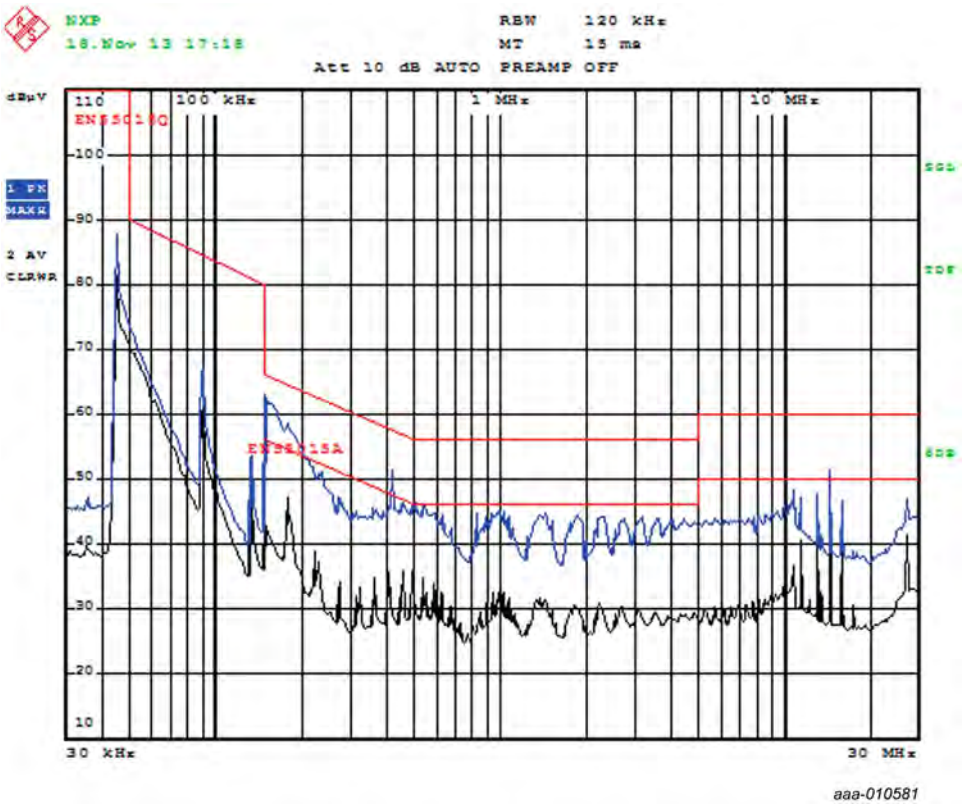

Fig 13. EMI performance SSL5018DB1125 demo board

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8. Schematic

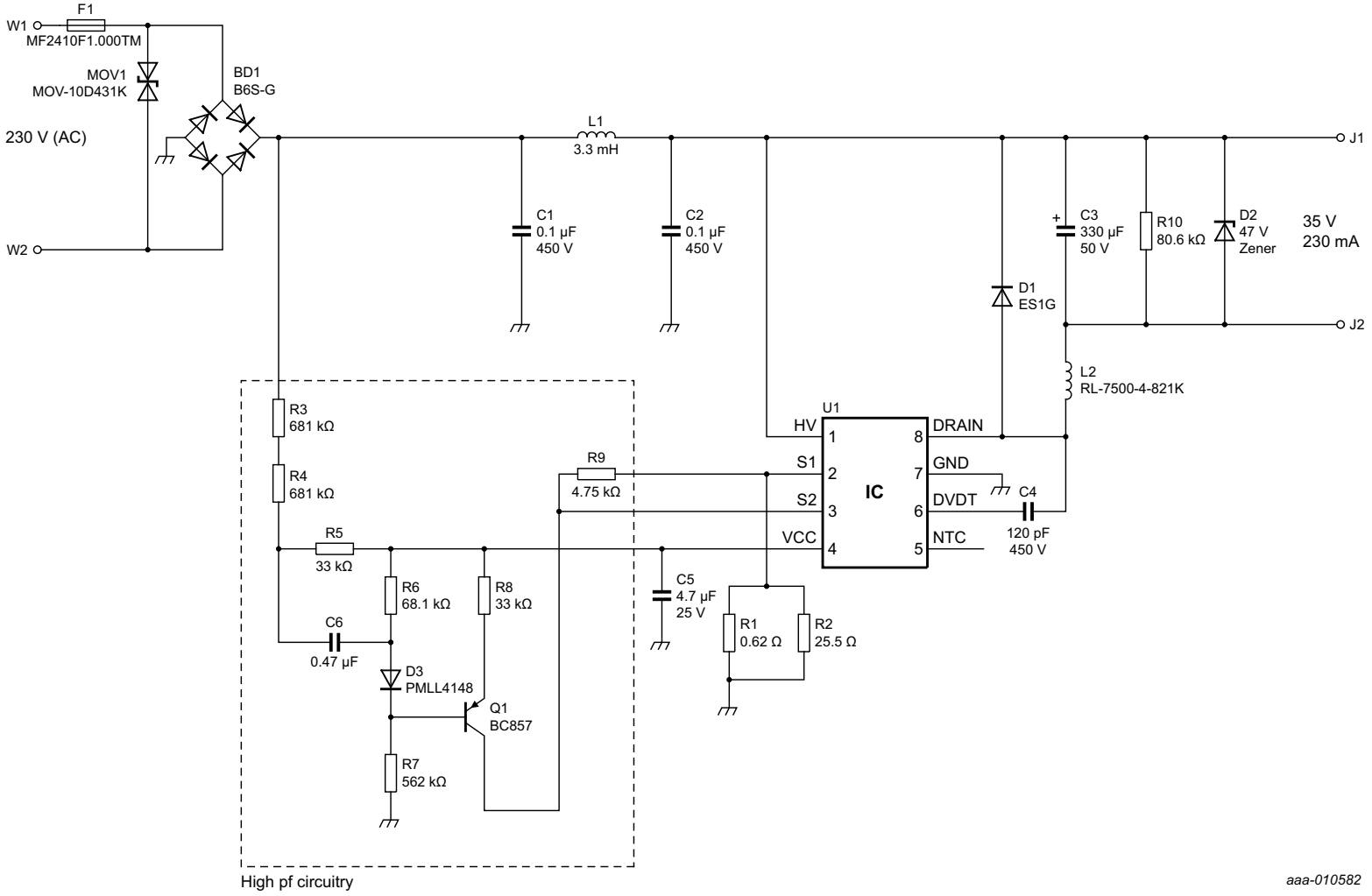

Fig 14. SSL5018DB1125 demo board schematic

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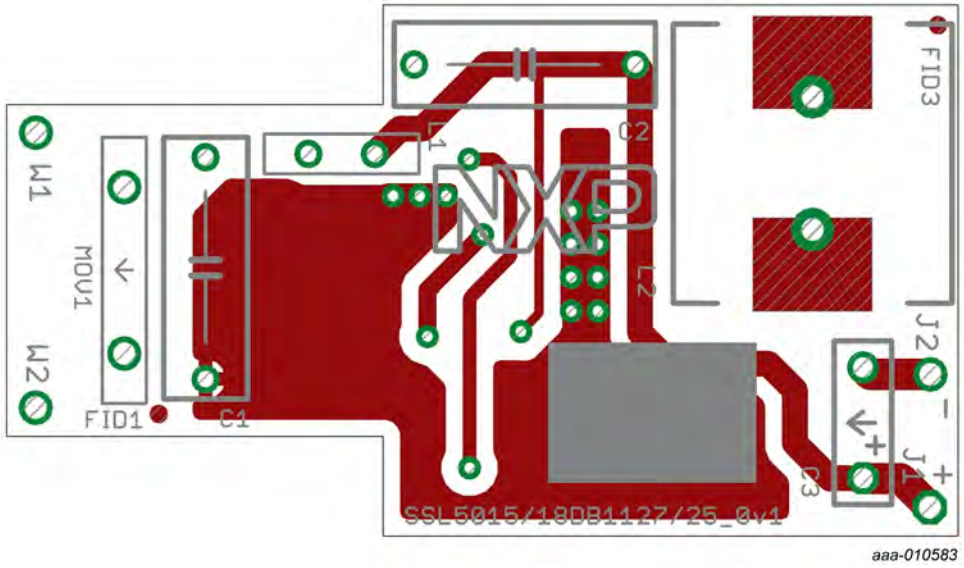
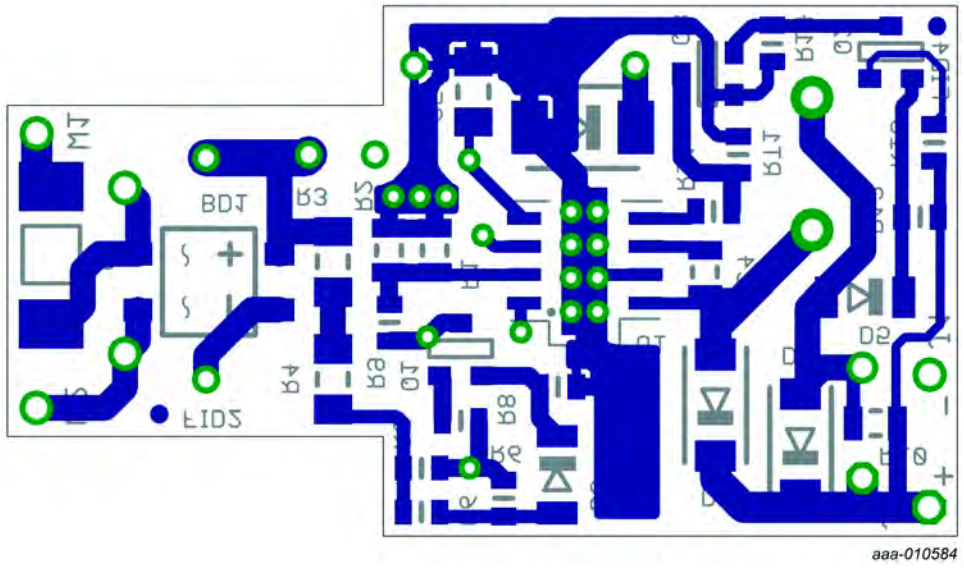
9. Board layout



a. Top



b. Bottom

Fig 15. SSL5018DB1125 demo board layout

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10. Bill Of Materials (BOM)

Table 2. SSL5018DB1125 demo board BOM

Reference	Description and values	Part number	Manufacturer
C1; C2	capacitor; 0.1 μF; 450 V	ECW-F2W104JAQ	Panasonic
C3	capacitor; 330 μF; 50 V	EEU-EB1H331	Panasonic
C4	capacitor; 120 pF; 450 V; C0G; 0805	CGA4C4C0G2W121J060AA	TDK
C5	capacitor; 4.7 μF; 25 V; X7R; 1206	C3216X7R1E475K160AC	TDK
C6	capacitor; 0.47 μF; 50 V; X7R; 0603	UMK107B7474KA-TR	Taiyo Yuden
BD1	bridge rectifier; 600 V; 0.8 A	B6S-G	Comchip Tech
D1	fast diode; 400 V; 1 A	ES1G	Fairchild Semiconductor
D2	zener diode; 47 V4	SMAJ5941B-TP	Micro Commercial
D3	diode; 75 V; 200 mA	PMLL4148	NXP Semiconductors
L1	inductor; 3300 μH	RLB0812-332KL	Bourns
L2	inductor; 820 μH	RL-7500-4-821K	Renco Electronics
Q1	transistor; 45 V; PNP	BC857	NXP Semiconductors
R1	resistor; 0.62 Ω; 0805	RCWE0805R620FKEA	Vishay Dale
R2	resistor; 25.5 Ω; 0805	ERJ-6ENF25R5V	Panasonic
R3; R4	resistor; 681 kΩ; 1206	ERJ-8ENF6813V	Panasonic
R5	resistor; 33 kΩ; 0603	ERJ-3EKF3302V	Panasonic
R6	resistor; 68.1 kΩ; 0603	ERJ-3EKF6812V	Panasonic
R7	resistor; 562 kΩ; 0603	ERJ-3EKF5623V	Panasonic
R8	resistor; 33 kΩ; 0603	ERJ-3EKF3302V	Panasonic
R9	resistor; 4.75 kΩ; 0603	ERJ-3EKF4751V	Panasonic
R10	resistor; 80.6 kΩ; 0805	ERJ-3EKF8062V	Panasonic
MOV1	varistor; 250 V (AC)	MOV-10D431K	Bourns
U1	IC; SSL5018; HSO8	SSL5018TE	NXP Semiconductors
F1	fuse; 250 V (AC); 1 A; 2410	MF2410F1.000TM	AME

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